MDUG-CWL/14501E-01 Rev.1

Utility software for Cool Muscle

COOL WORKS LITE [Ver. 4.4.1]
USER'S MANUAL

MUSCLE
CORPORATION

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Chapter 1

Installation

COOL WORKS LITE

COOL WORKS LITE (CWL) is a utility software for Cool Muscle.
CWL can communicate with a Cool Muscle directly. It lets you modify and save parameters and data. It can jog the motor, plot motor data on a graph and do gain tuning. CWL is Cool Muscle Language (CML) compatible.
CWL is a user-friendly software. It assists in easy operation of Cool Muscle.

Main features

① In the terminal window, data and bank programs can be set and the status of motion monitored. (Terminal function)
② In the motor browser window, the motor parameters are easily set. (Motor browser function)
③ In the Jog window, the motor can be rotated by dragging a slider with the mouse. (Jog motion function)
④ In the graph window, the position, speed, torque, etc can be displayed graphically in real time. (Graph function)
⑤ In the Response Adjustment window, controller gain can be easily tuned by step response or frequency-response. (Response Adjustment function)

The latest COOL WORKS LITE can be downloaded for free from the following web site by answering a simple questionnaire: http://www.musclecorp.com/

Compatible OS: WINDOWS 7

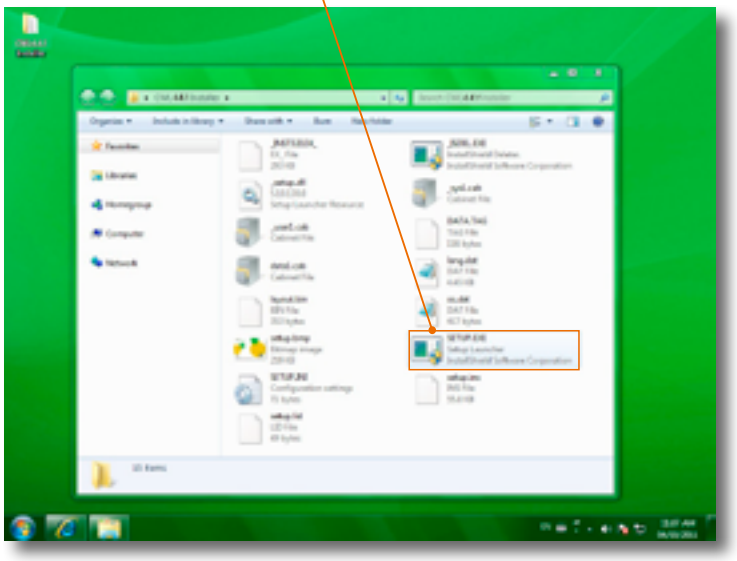
File Size: 2.74MB

*CWL would be updated without notice.

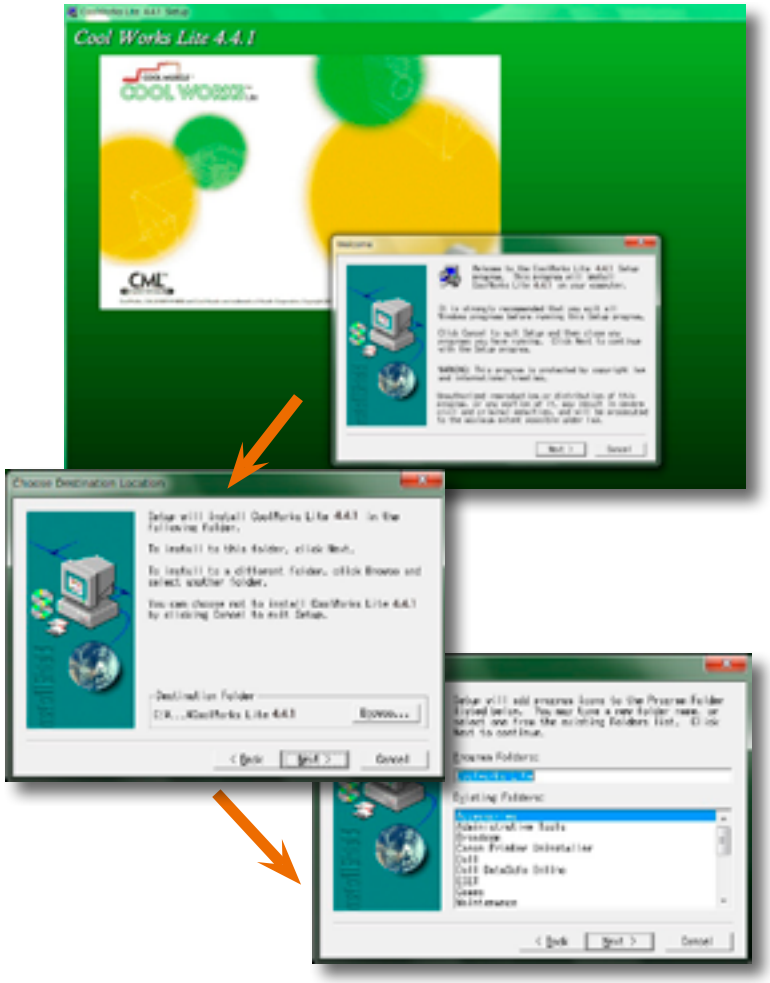
Installation

1. Extract the downloaded zip file and unzip it.

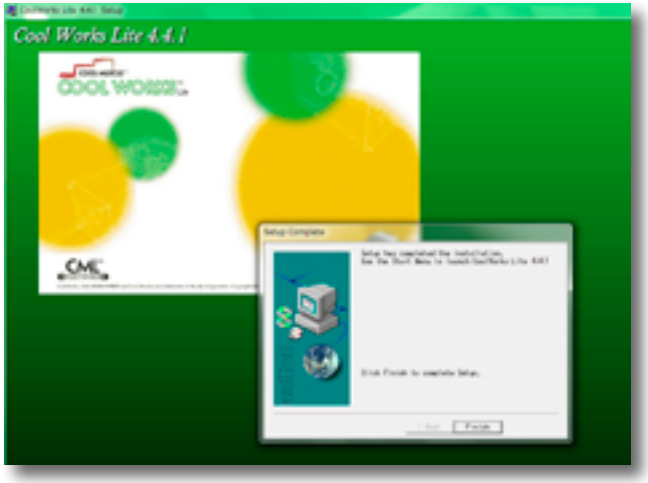
2. To install, click SETUP.exe in the folder where the files are extracted.



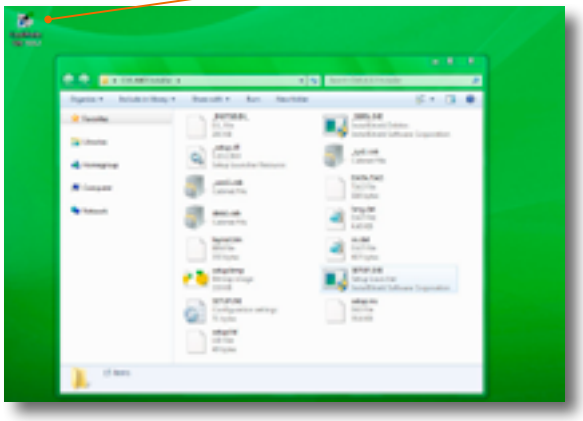
3. Choose the folder to install CWL according to the instructions given by the installer. Click [Next] button to continue.



4. To complete the installation, click [Finish] button.



5. When the installation is completed successfully, an icon will be appeared on your desktop.



Chapter 2

Startup and Initial Settings

1. Make sure DC+24V power supply is OFF.

Connect the PC, DC+24V and Cool Muscle by a RS-232C cable (CM1C2-2000A) according to the following diagram.

Caution: Do not plug or unplug the connector when the power is on. This can cause damages to Cool Muscle or other devices.

*Please pay attention to the direction of the connector.

Cool Muscle

< Connection example >

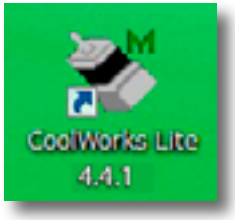
RS-232C cable

RS-232C connector

Connect to PC's RS-232C port

DC+24V power supply

2. After turning on the DC+24V power supply, double click CoolWorks Lite 4.4.1 icon to open CWL.



3. Fill in the necessary information:

① Choose the Communication Type. Default is Serial communication.

② Choose the Baud Rate. Default is 38400bps.

③ Choose the COM Port.

Enter COM port number which the Cool Muscle is connected.

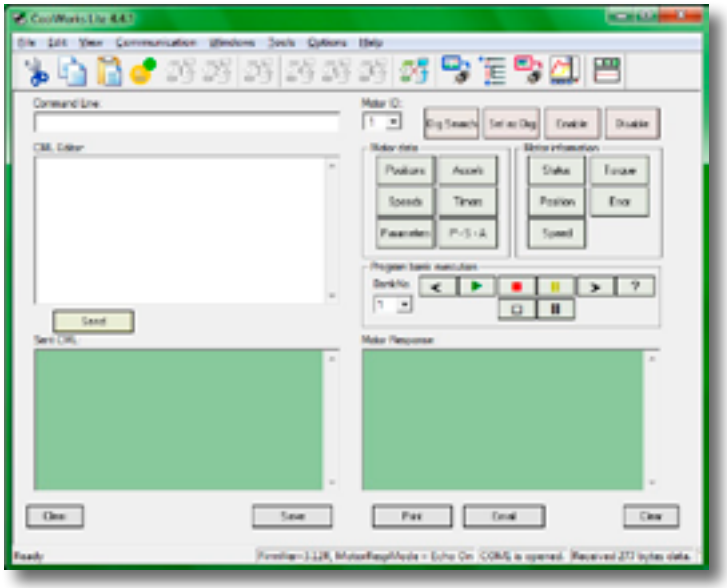
Remark: Please refer Page 24 about how to find the available COM port in your computer.

④ Start communication by clicking on the [Open COM] Button.

To start communication and open the terminal window, click [Open COM].

To close the CWL program, click [Exit].

4. The terminal window is now displayed.



Chapter 3

General Terminology and Descriptions

The menu bar for all the windows

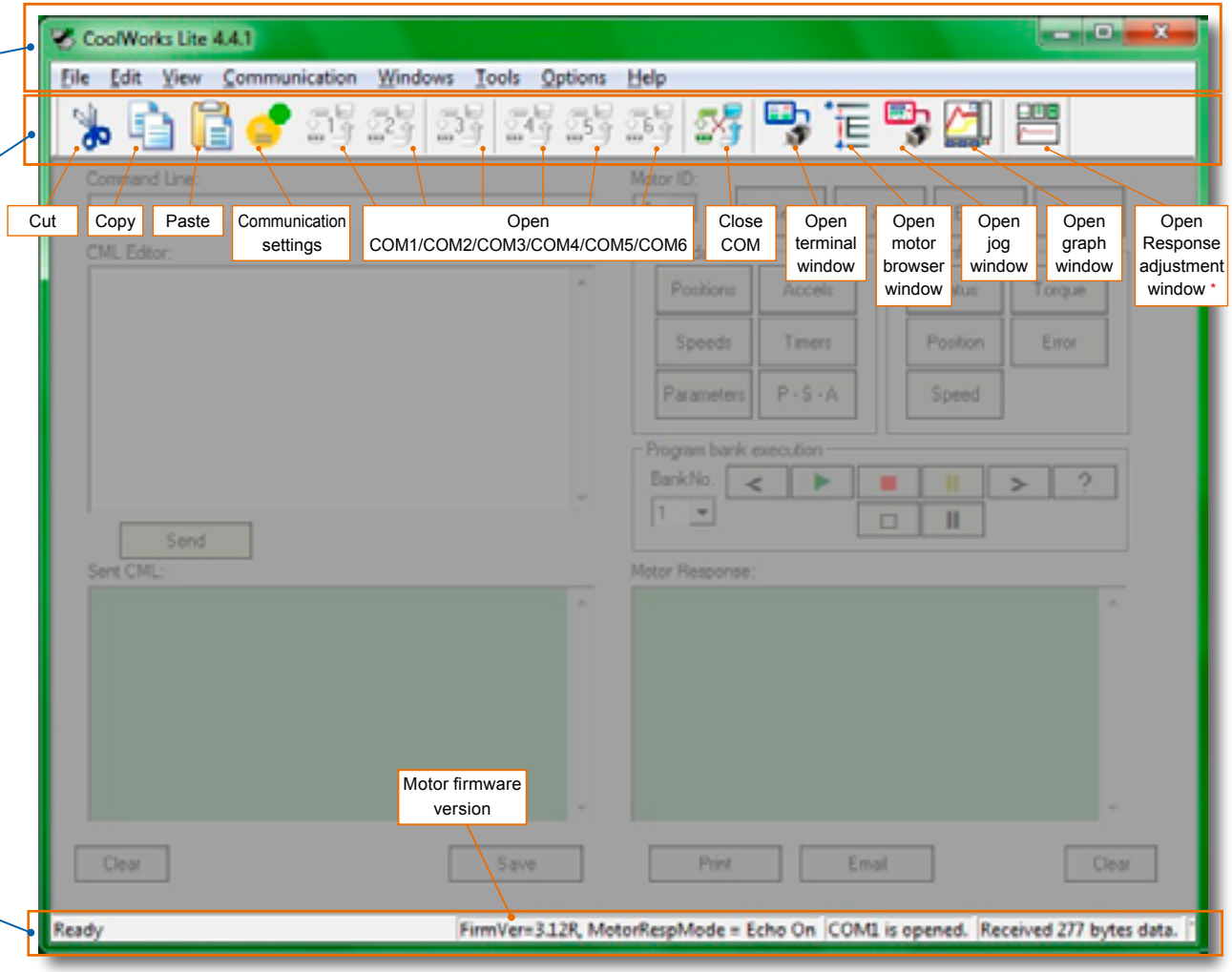
① Menu Bar

See Page 6 for details.

② Tool bar

Select windows and functions through icons.

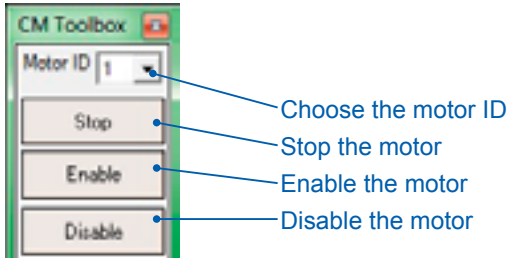
* Response adjustment window will not work for Ver 3.00 and 1.07 or before.

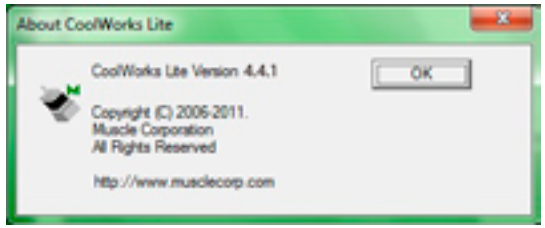


③ Status bar

Displays the motor status and other relevant CWL information.

① Menu bar

Menu	Name of Item	Description
File	Open	Open a selected file into the CML Editor
	Exit	Close COOL WROKS LITE
Edit	Undo	Undo of the last action
	Cut	Cut the selected area
	Copy	Copy the selected area to the clipboard
	Paste	Paste the contents on the clipboard
View	CM Toolbox : Display the CM toolbox on the upper left corner of the screen  	
	Toolbar	Set Show/Hide toolbar
	Status Bar	Set Show/Hide Status bar
	Language	Set the language for CWL
Communi-cation	COM1	Open COM port 1
	COM2	Open COM port 2
	COM3	Open COM port 3
	COM4	Open COM port 4
	COM5	Open COM port 5
	COM6	Open COM port 6
	Close	Terminate communication

Windows	Terminal	Display the terminal window (main window)
	Motor Browser	Display the motor browser window
	Jog	Display the jog window
	Graph	Display the graph window
	Response Adjustment *1	Display the response adjustment window
Tools	Speed Calculator *2	Convert the speed value from rpm to pps
	Motion Calculator *3	Calculate the motion data according to given position, speed, acceleration and time
	Copy Motor Settings *4	Copy the settings from one motor to the other
Options	Data Log *5	Record the log file of incoming messages from motors
Help	Contents	————
	About COOL WORKS LITE : The version information for COOL WORKS LITE is displayed in the following window  	

*1 The Response Adjustment window cannot be used for firmware Ver. 1.07 or before.

*2-5 Please refer to page 7-8 for the details.

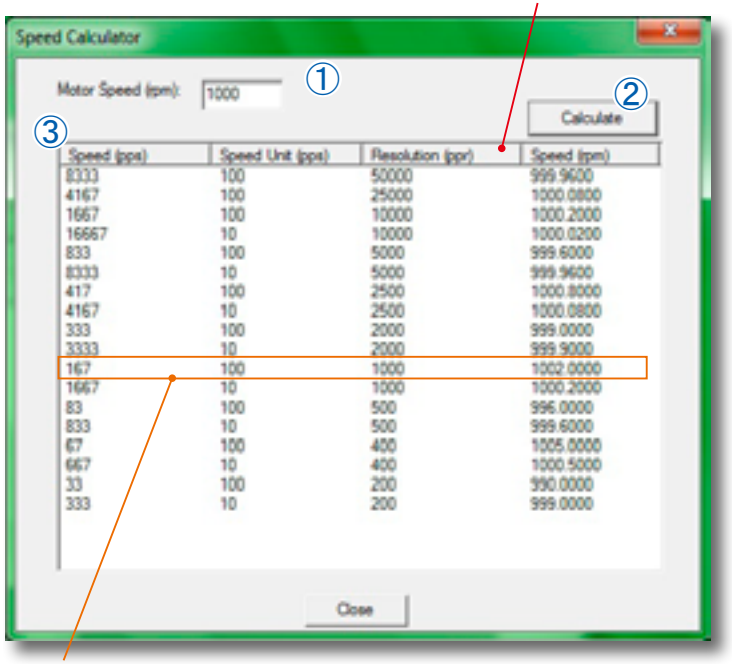
*2 Speed Calculator

① Enter the target speed in rpm.

② Click [Calculate] button.

③ Calculate the Speed value in pps for given resolution.

* Since the incremental motion can not be executed when K37=40s and 60s (Except for K37=41 and 61), the speed calculator does not show the resolutions for K37=40s and 60s.

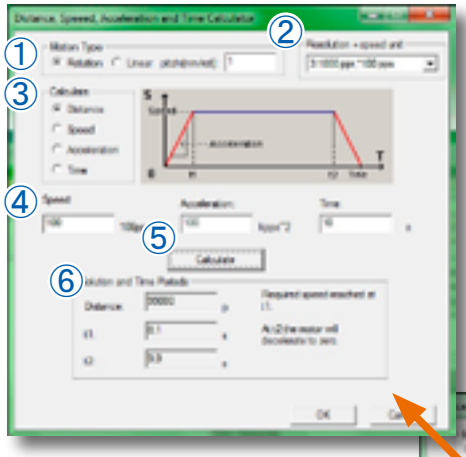


Speed (pps)	Speed Unit (pps)	Resolution (ppr)	Speed (rpm)
8333	100	50000	999.9600
4167	100	25000	1000.0800
1667	100	10000	1000.2000
16667	10	10000	1000.0200
833	100	5000	999.6000
8333	10	5000	999.9600
417	100	2500	1000.8000
4167	10	2500	1000.0800
333	100	2000	999.0000
3333	10	2000	999.9000
167	100	1000	1002.0000
1667	10	1000	1000.2000
83	100	500	996.0000
833	10	500	999.6000
67	100	400	1005.0000
667	10	400	1000.5000
33	100	200	990.0000
333	10	200	999.0000

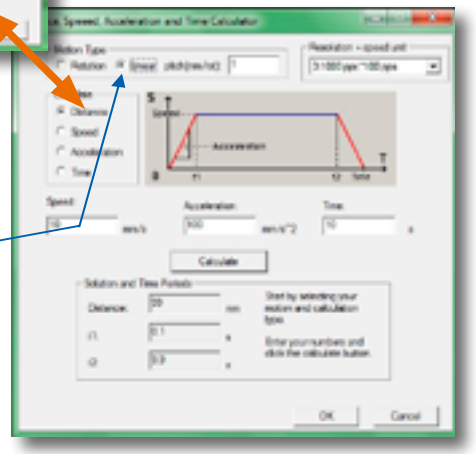
For the above case where the Resolution is 1000ppr and Speed Unit is 100pps, s=167 is calculated as 1002rpm.

*3 Motion Calculator

① Set motion type. ② Set the combination of resolution and speed unit. ③ Choose distance, speed, acceleration or time to be calculated. ④ Enter the necessary data for calculation. ⑤ Click [Calculate] button. ⑥ The chosen variable and time for motion will be calculated.



In the left case, distance of Rotation type is selected.
Resolution = 1000ppr.
Speed unit = 100pps.
Speed=10000(100*100)pps,
Acceleration=100kpps² and
Time = 10s.
The rotation distance is calculated as 99000 pulses.



To transform the result to the other motion type (in this case it is Linear type), simply change the motion type. You will have to enter the pitch data first.

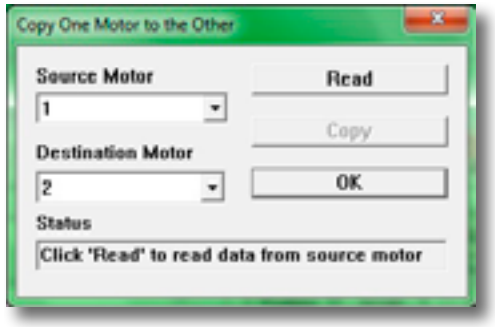
* Enter the pitch data in the Linear type.

*4 Copy Motor Settings

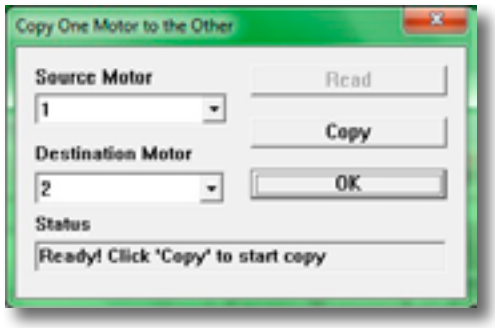
Copy the motor parameters and program banks from one motor to the other.

Caution: The settings for the motor depend on its type. Such as 23L, 17S, C type and P type. Please be careful when copying between motors with different types.

① Select the source motor ID. To read the data, click [Read] button.



② Select the destination motor ID. To copy the motor settings, click [Copy] button.

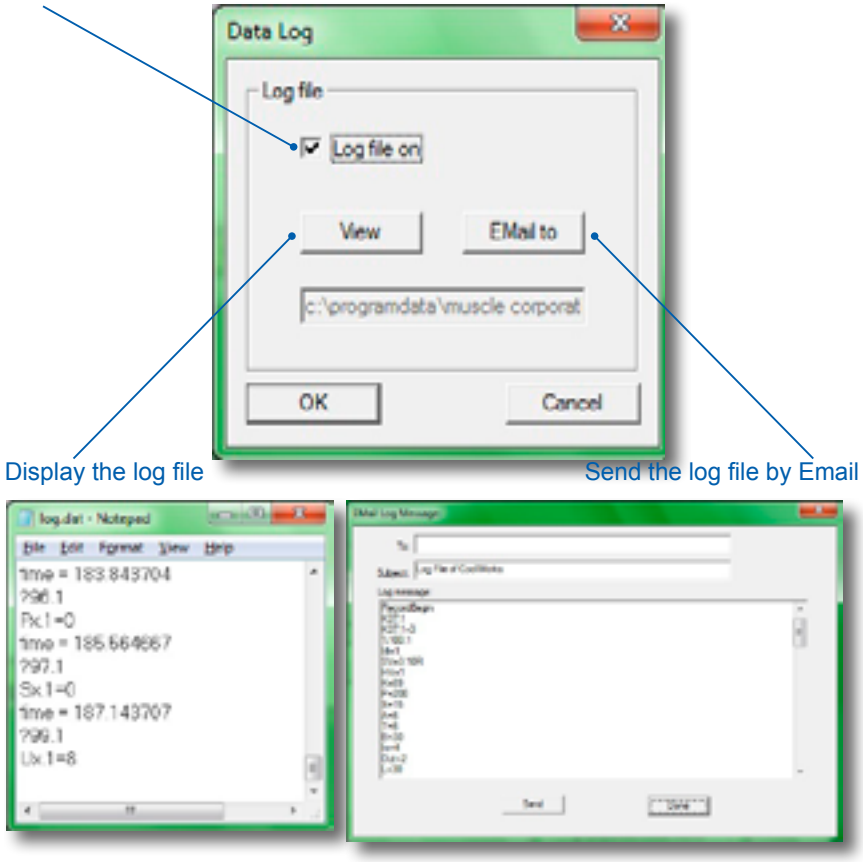


*5 Data Log

To record the incoming messages from the motors, check [Log file on].

*The [Log file on] is not checked by default.

The log file will be reset if [Log file on] is unchecked or CWL is closed.



Chapter 4

Terminal Window

How to Use Terminal Window

The first window displayed after opening CWL and selecting a COM port is the terminal window.

The terminal window allows reading and writing of motor data, parameters and program banks.

Text files created in other editors, for example, notepad, can be read into this window. It is convenient to save data as a file and use it later repeatedly.

① Command Line

Enter CML commands in a single line and press [Enter] key to send.

② CML Editor

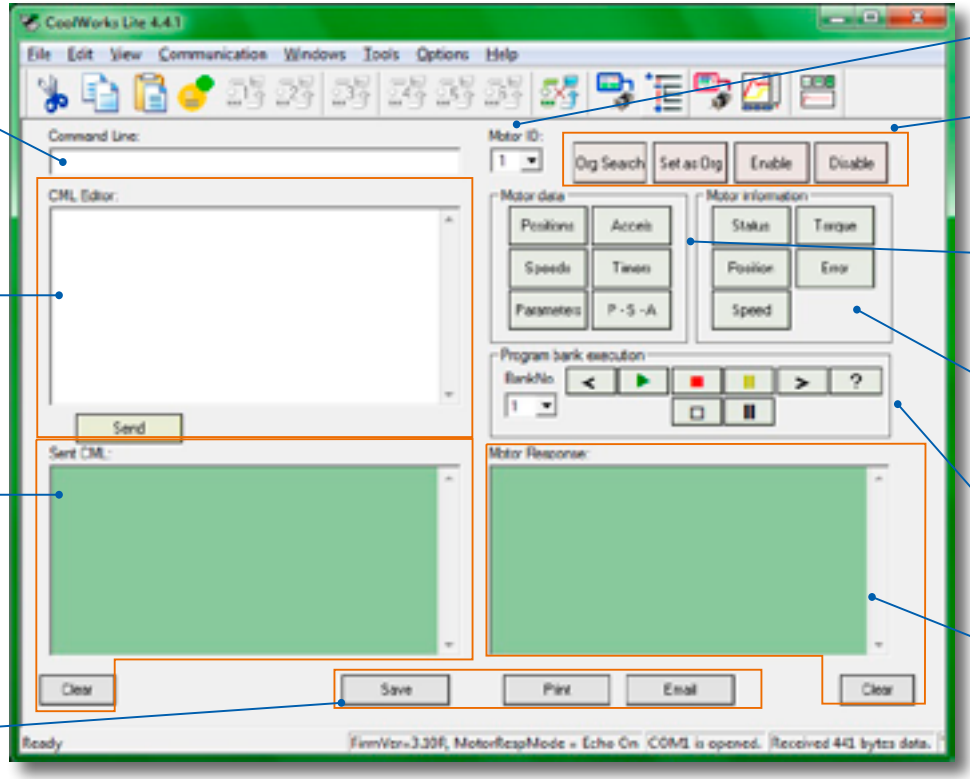
Send multiple lines of CML at the same time. To send a set of commands click [Send] button.

③ Sent Data

Display the data sent to the motor in ① or ② . To clear the motor response window click [Clear] button.

④ Save / Print / Email

Save / Print / Email the data which is sent to or received from motors.



⑤ Motor ID

Select the target motor ID.

⑥ Function Buttons

Go to origin. Reset motor coordinates and motor Enable / Disable.

⑦ Motor data

See Page 10 for details.

⑧ Motor information

See Page 10 for details.

⑨ Buttons for Program bank

See Page 10 for details.

⑩ Motor Response

Display the data received from the motor. To clear the Motor Response window click [Clear] button.
The data log file will not be affected by clicking [Clear] button.

⑦ Motor data

Button	Query	Description
Positions	?91	Display the list of position data
Accels	?93	Display the list of acceleration data
Speeds	?92	Display the list of speed data
Timers	?94	Display the list of timer data
Parameters	?90	Display the list of K parameters
P-S-A	?	Display the data for direct mode motion

⑧ Motor information

Button	Query	Description
Status	?99	Display current motor status
Torque	?98	Display current motor torque
Position	?96	Display current motor position
Error	?95	Display current position error
Speed	?97	Display current motor speed

⑨ Buttons for Program bank

Button	Command	Description
Bank No. 1		Choose bank No. from the list (1-30)
<	<.1	Execute previous line of a bank
▶	[m.1	[m.1 Execute bank m in motor 1
■	].1].1	Stop bank execution
□	}.1 }.1	Stop bank execution after current motion
‖	].1	Pause bank execution
‖	}.1	Pause bank execution after current motion
>	>.1	Execute the next line of a bank
?	?m.1	Display bank m in motor 1

* m is selected from the Bank No. list. * ID1 must be selected in ⑤ Motor ID.

Chapter 5

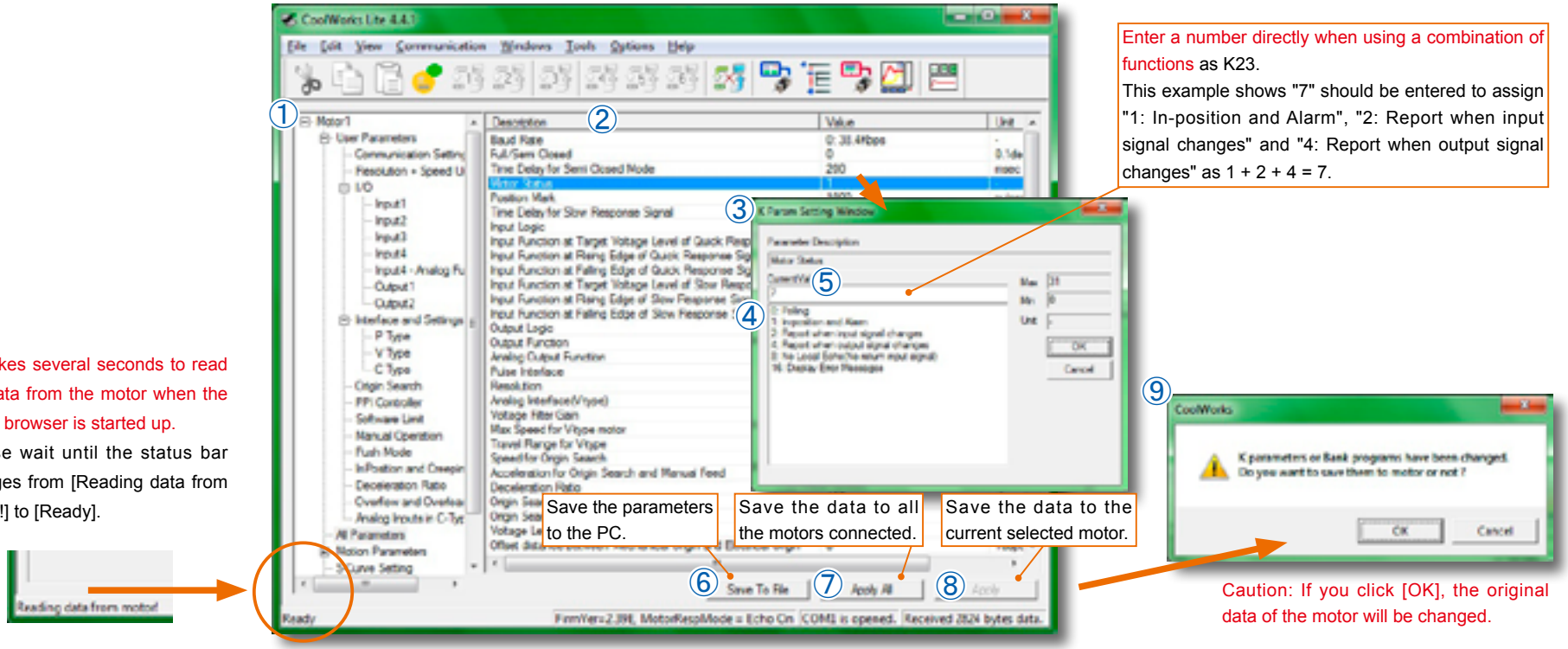
Motor Browser Window

How to Use Motor Browser Window

Motor data and parameters can be set up by features.

① Open the feature folder which you want to check or change. ② The list of parameters related to this feature are displayed in the right window. Choose and double click the parameter that you want to modify. ③ The setting window of the parameter is displayed. ④ In order to change the data, choose an item from the data list or ⑤ enter data directly and then click [OK]. *At this point, the modified data has not been sent to the motor.

After modifying all the data, click ⑦ [Apply All] or ⑧ [Apply]. ⑨ A dialog box is displayed. To save the data to the motor, click [OK]. To save the parameters to the PC, click ⑥ [Save To File]. *Only parameters can be saved in PC.


Enter a number directly when using a combination of functions as K23.
This example shows "7" should be entered to assign "1: In-position and Alarm", "2: Report when input signal changes" and "4: Report when output signal changes" as 1 + 2 + 4 = 7.
* It takes several seconds to read the data from the motor when the motor browser is started up.
Please wait until the status bar changes from [Reading data from motor!] to [Ready].
Reading data from motor!
Save the parameters to the PC.
Save the data to all the motors connected.
Save the data to the current selected motor.
Caution: If you click [OK], the original data of the motor will be changed.

Chapter 6

Jog Window

How to Use Jog Window

This window is for a jog motion with the mouse pointer. The resolution and speed unit can be set.

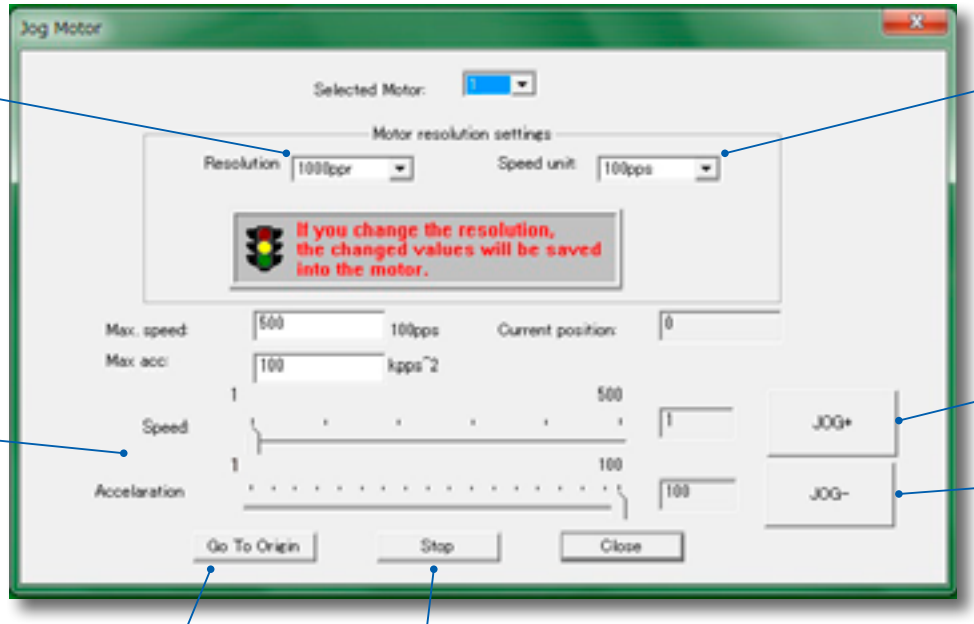
For jog motion, click the JOG button. The resolution changed in this window will be saved to the motor.

* Any modification of the resolution and speed unit will be saved to the motor. The current position is displayed according to the modified resolution.

Choose Resolution from 200-50000 ppr

* Since the incremental motion can not be executed when K37=40s and 60s (Except for K37=41 and 61), this list does not show the resolutions for K37=40s and 60s.

Set speed and acceleration for jog motion.
When changing values during jog motion, the values are reflected to the motion.



Choose Speed unit 100pps or 10pps

Jog in CW direction

Jog in CCW direction

Move to the position 0

Stop motion

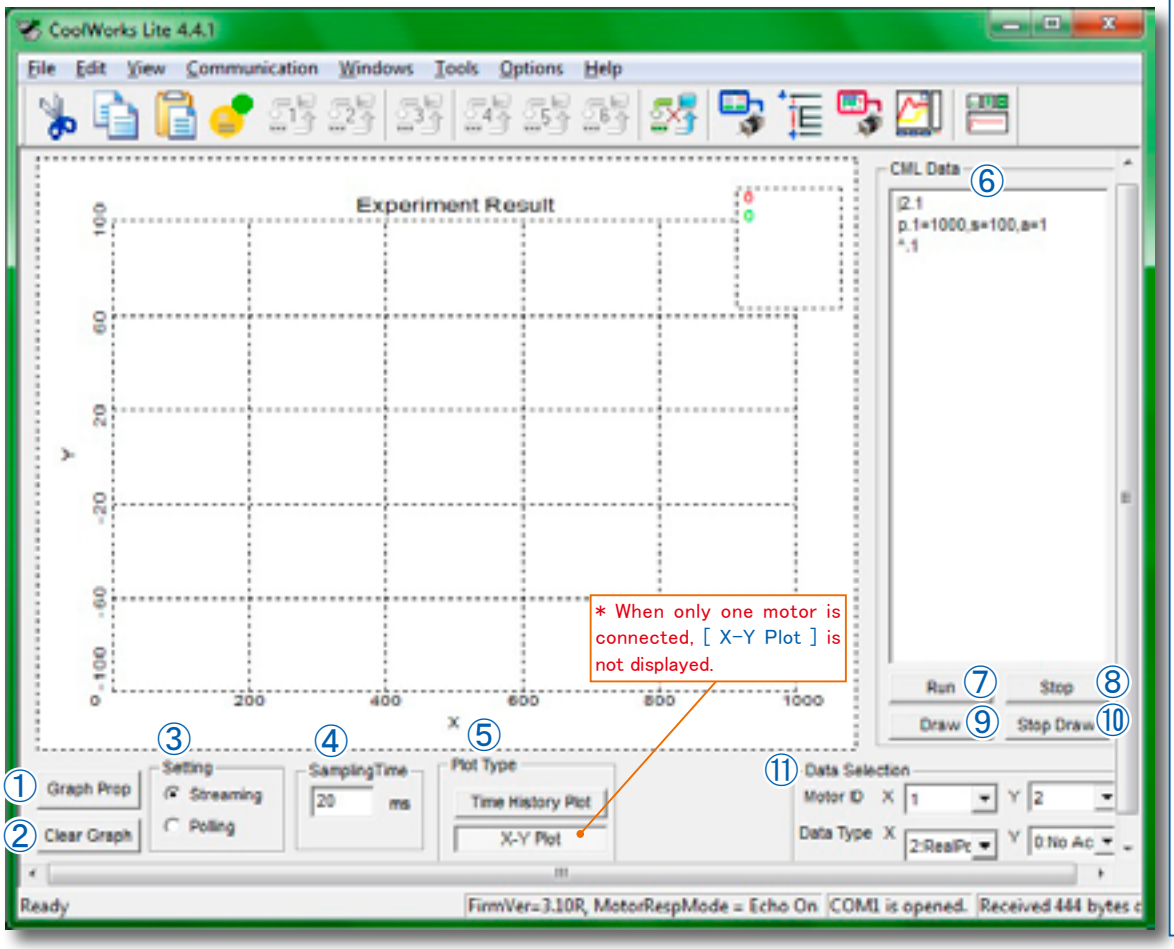
Chapter 7

Graph Window

Caution: Do not start-up the Graph Window function while Cool Muscle is not powered on or executing communication frequently.
Doing so may cause CWL to stop working and to be inoperative subsequently.
To recover from such unusual situation, the reinstall of CWL is necessary.

How to Use Graph Window

The specified data can be displayed in a graph. Operate according to steps from ①～⑪ .



① Graph Prop

Set the necessary data. (See Page 14 for details)

② Clear Graph

Clear graphical data displayed.

③ Setting

Choose Streaming for Ver 2.20 or after.

Choose Polling for Ver1.07 or before.

④ Sampling Time (unit: msec)

The sampling time for data streaming or polling. (1-30000)

⑤ Plot Type (See Page 15 and 16 for details)

[Time History Plot]: Display the data trend versus time.

[X-Y Plot]: Display two related data in an X-Y plane.

Choose one of the two.

* When only one motor is connected, [X-Y Plot] is not displayed.

⑥ CML Data

Please enter the motion commands in this window which will be used for generating the graph. Any direct motion commands or bank programs are available.

⑦ Run

Run the motor according to the CML data given.

⑧ Stop

Stop the motion.

⑨ Draw

Draw the graph.

⑩ Stop Draw

Stop drawing the graph.

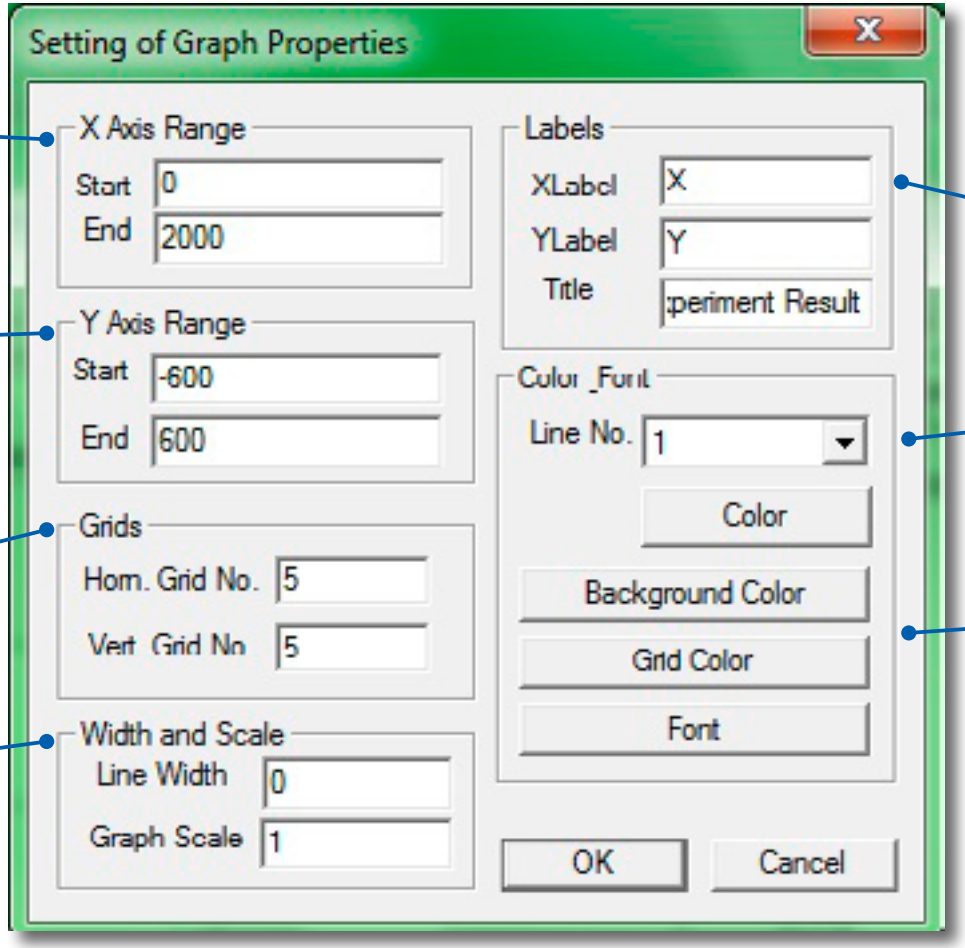
⑪ Data Selection

To select the data for monitoring, first select the motor ID from [Motor ID] and then select data type from [Data Type] for each motor.

Streaming	Polling
0: No Action	0: No Action
1: Target Speed	1: Real Position
2: Real Position	2: Real Speed
3: Real Speed	3: Torque
4: Torque	4: Position Error

① Setting of Graph Properties

To display the following window, click [Graph prop] button.



Set the minimum and maximum values for the X axis (an integer between -32767 and 32767).

Set the minimum and maximum values for the Y axis (an integer between -32767 and 32767).

Set the horizontal and vertical grid numbers (an integer between 1 and 32767).

Set the width of the line and the scale of the data.

Set the labels for the X axis, Y axis and title.

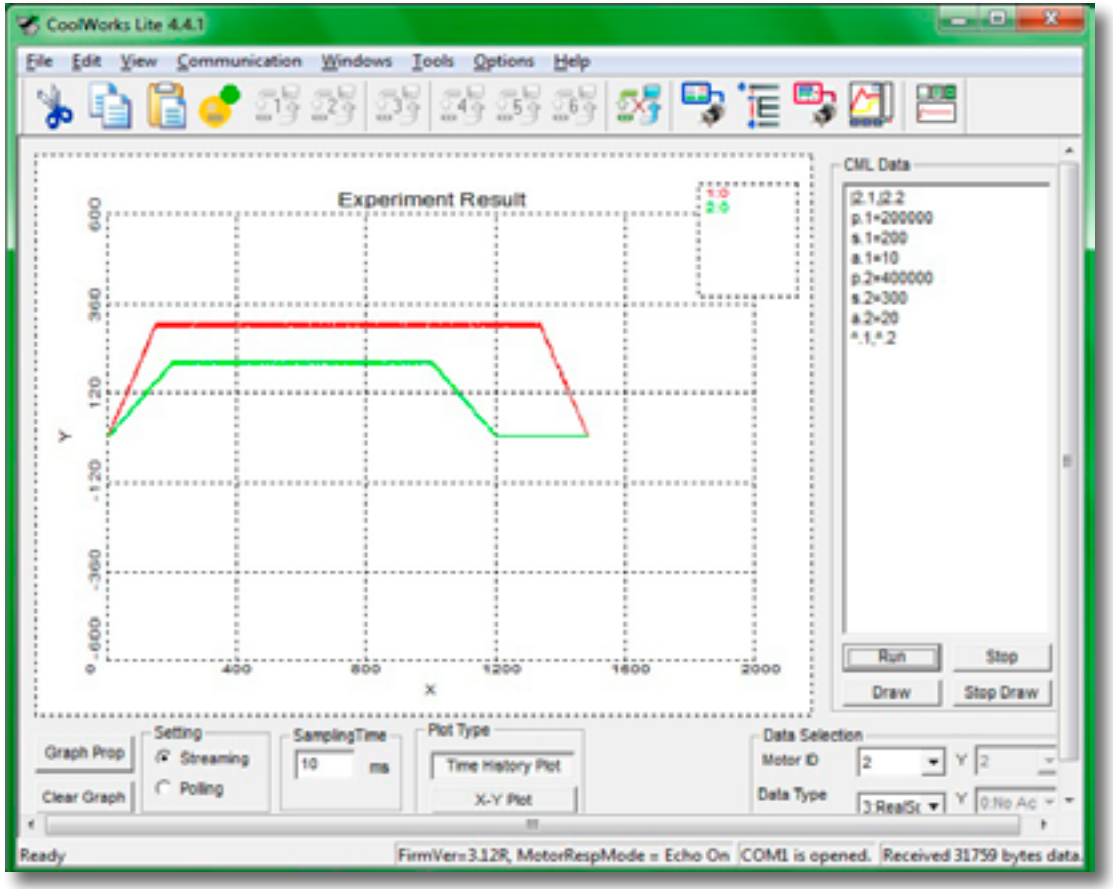
The color of each data line can be independently defined.

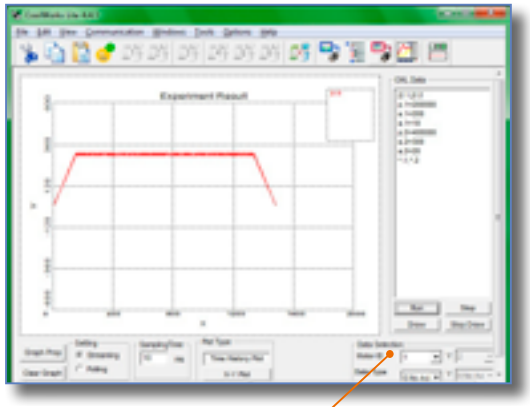
Set the Background Color, Grid Color and Font.

④ Plot Type [Time History Plot]

The time history plot, data (Y axis) can be displayed versus time (X axis). Unit for the X axis is SamplingTime (msec).

*When multiple motors are selected, graphs will be displayed only when the motor of the final axis is in motion.





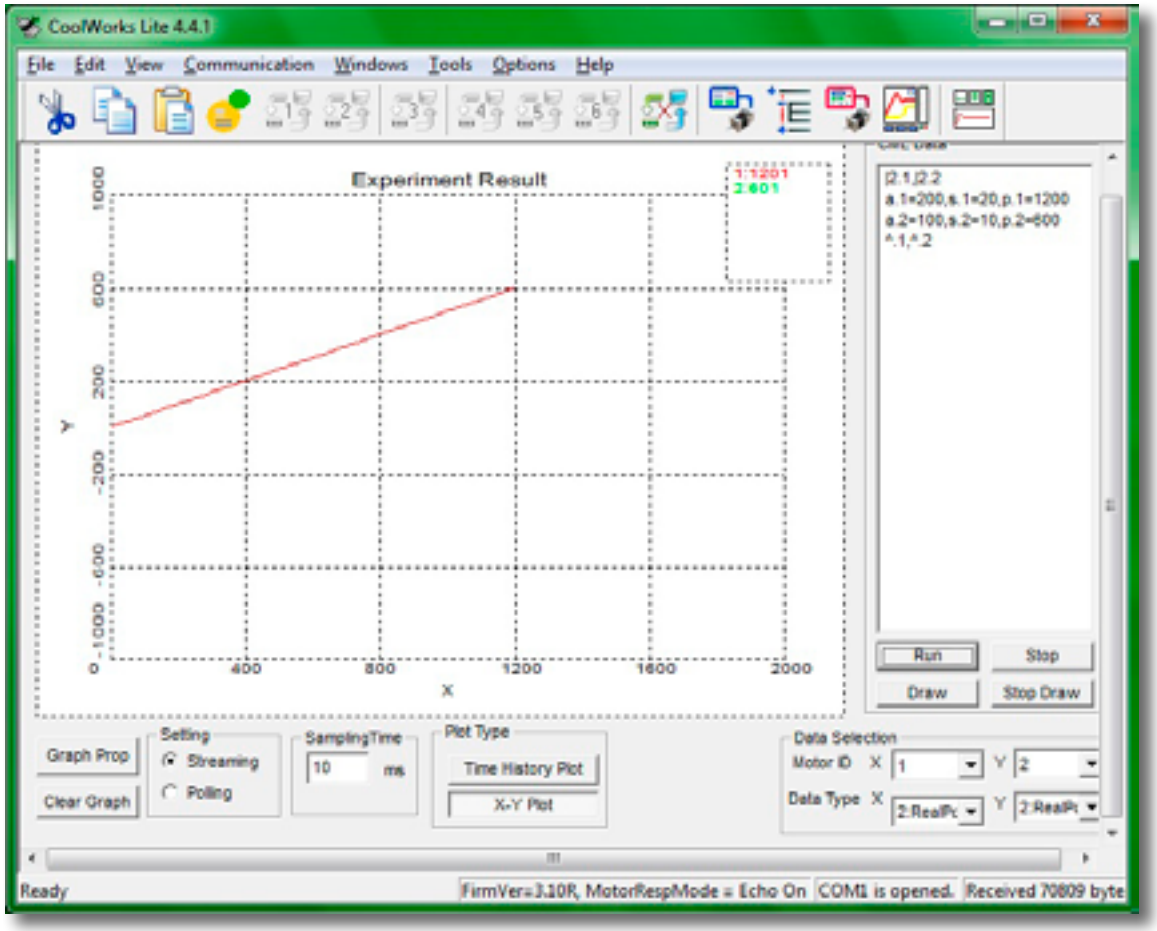
Even when multiple motors are connected, the data from specified motors can be obtained by setting unspecified motor's Data Type as [0: No Action].

④ Plot Type [X-Y Plot]

＊When only one motor is connected, [X-Y Plot] is not displayed.

Related data will be displayed in X-Y plane. (The following example is real time position display)

*When multiple motors are selected, graphs will be displayed only when the motor of the final axis is in motion.



Chapter 8

Response Adjustment Window

Caution: Motor will vibrate during the identification and tuning process.

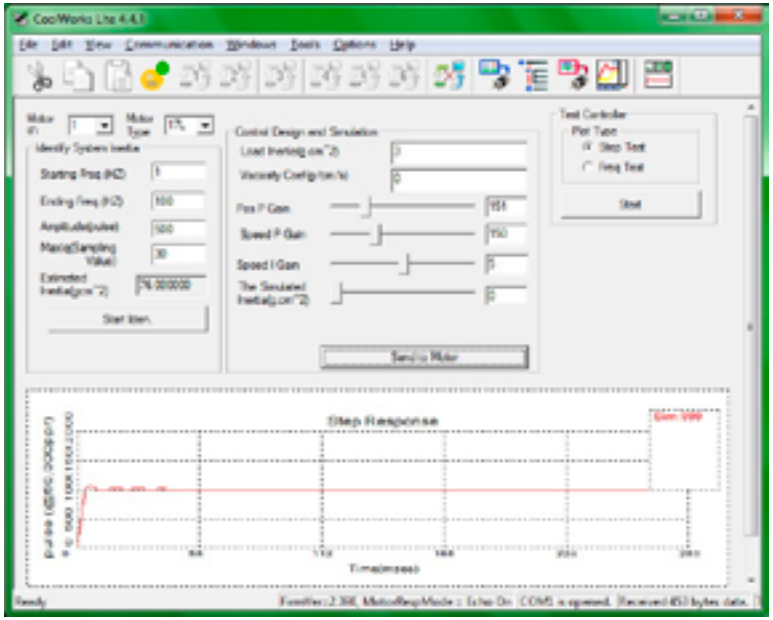
* This window will not work for Ver 3.00 and 1.07 or before.
* It is not auto tuning.

Type of Response Adjustment Window

The screen configuration depends on Cool Muscle's version.

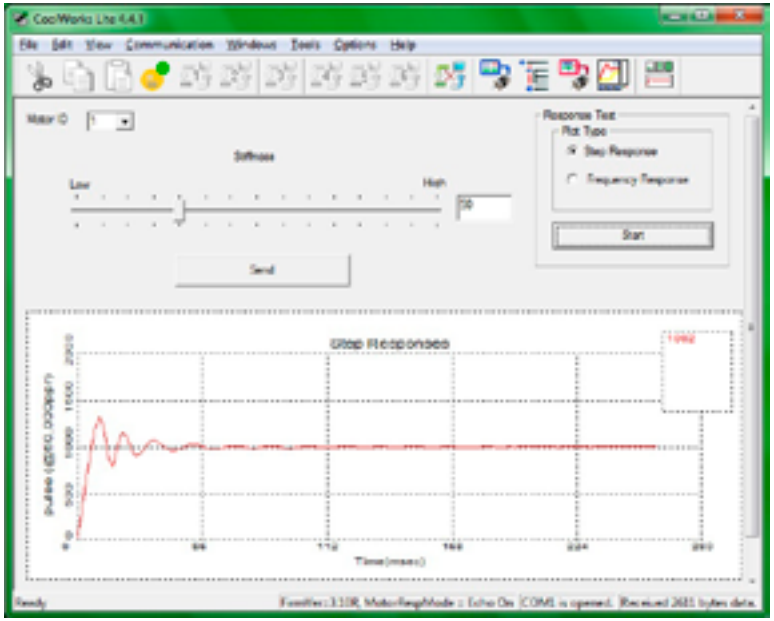
For CM1 (ver.2.XX)

Tuning and simulation are available. (See Page 18~21 for details)



For CM2 (ver.3.XX)

Servo stiffness adjustment is available. (See Page 22 for details)



How to Use Response Adjustment Window (for CM1)

The Response Adjustment window can simulate and assist tuning the PPI control parameters.

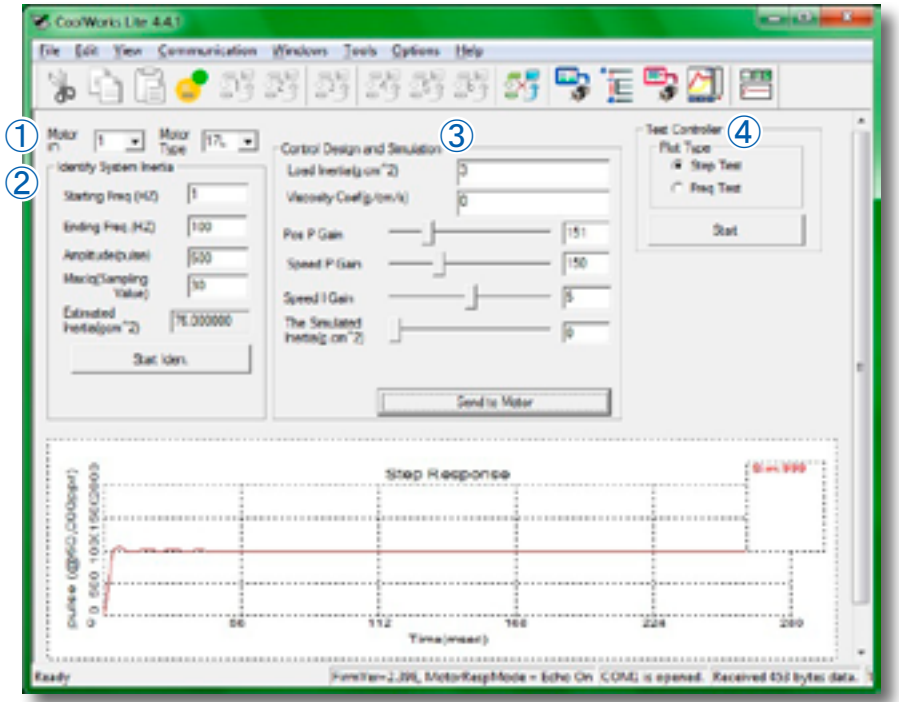
① Motor Selection

Choose Motor ID and Motor Type.

② Identify System Inertia (Optional)

Calculate and display the inertia of the payload by experimental results based on the vibration starting from [Starting Freq] to [Ending Freq] with the given Amplitude.

(See Page 19 for details)



③ Control Design and Simulation

Position P Gain, Speed P and I Gain can be tuned by comparing the results of the simulation for a given inertia and viscosity coefficient.

(See Page 19 for details)

④ Test Controller

Test results for Step and Frequency responses are available.

(See Page 20 and 21 for details)

The tuning result is dependent on the payload inertia. ② Identify System Inertia is a tool to identify the payload inertia when the design value is unknown. All the conditions for identification must be set properly in order to get an accurate estimation. The identification results might be different if the experimental conditions are not set properly. The estimated result might not be accurate enough even under the proper experimental condition. The estimated data is a reference to adjust the tuning. The parameters must be tuned with a trial motion. ③ Control Design and Simulation: Simulate with different inertia. If the inertia of payload is unknown use the inertia identification function.

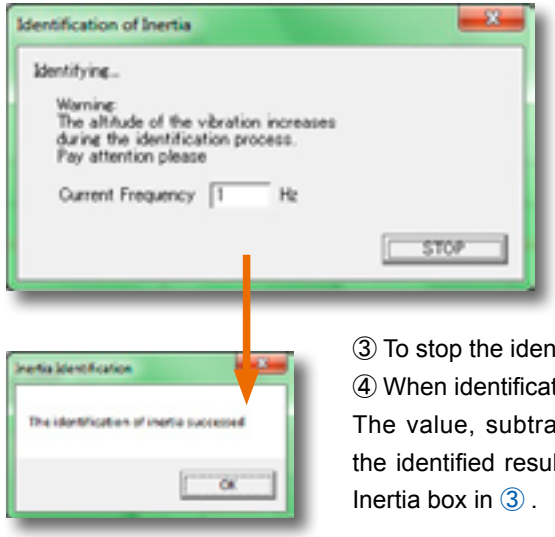
[Identification] is to add some probing signal to the system and estimate the unknown parameter of it in order to build a mathematical model for control design.

② Identify System Inertia

Identify the inertia of the playload by motor's information from vibration at specified frequency. Precise identification is achieved by aggregating the information from the motor by gradually increasing the vibration frequency.
The amplitude pulse setting shall always be based on 50000ppr despite the motor's set resolution.

Ex) The motor shaft will vibrate between plus minus 3.6 degrees (500pulses/50000ppr) when the amplitude pulse is set to 500.

① Enter the Starting frequency, Ending frequency, Amplitude and Max Iq.
(Set these values according to your machine)
② To start the identification, click [Start Iden.] button.
*The altitude of the vibration increases gradually during the identification process. Pay attention please.



③ To stop the identification, click [STOP].
④ When identification ends, click [OK].
The value, subtracted the rotor inertia from the identified result, will be entered into Load Inertia box in ③ .

[Identification Error]

The identification error will be occurred when the identification results do not converge which is tested at each frequency.
When the identification error occurs the data shall be reflected but the identification result shall be considered as inadequate. More precise identification result will be obtained by avoiding errors following the steps below.

Step 1. Increase the value for Max Iq (torque)

Motor Type	11S	11L	17S	17L	23S	23L
Max Iq (Torque)	40	50	50	90	140	150

If the identification error can not be avoided

Step 2. Decrease the value for amplitude pulse (pulse)
If the identification error can not be avoided

Step 3. Increase the value for ending frequency(Hz)

③ Control Design and Simulation

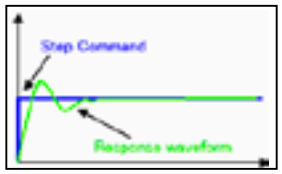
① Enter the inertia directly if it is known. If the inertia is already known and entered into this box, previous step is not necessary.
② Enter the viscosity coefficient if it is known. If it is unknown, enter 0.
③ Tuning of Position P Gain, Speed P Gain and Speed I Gain.
Click and drag the slider on one of the bars. The simulation result is displayed in the graph. Tune the gains refering to the simulation results.
The gain values can be entered directly, however the results is displayed only after the click of [Start] button in ④ .
* The data is not sent to the motor yet at this point.
④ Set the inertia for simulation to the same value as the normal payload.
However, you can set it to any value for the simulation.
⑤ To send the tuned gains to the motor, click [Send to Motor] button.
*The data will be sent to the motor.

④ Test Controller

Select Step Test or Freq Test.

[Step Test]

Step Test is as shown in the right, the output waveform when step shaped command is entered.
Step response test has the feature that shows the characteristic features intuitively and comprehensibly. Roughness could be still existing instead of the above features.
Step command 1000pulse / 50000ppr that is 7.2 degree on the motor shaft is applied for the step response test despite the motor's set resolution.

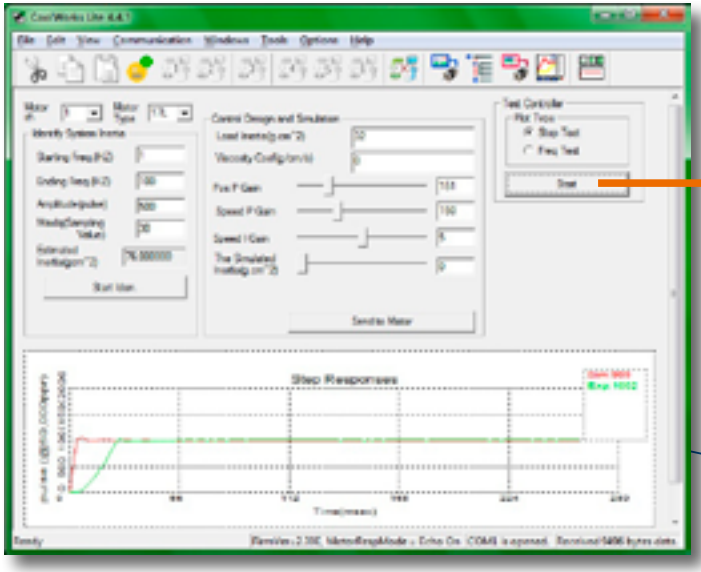


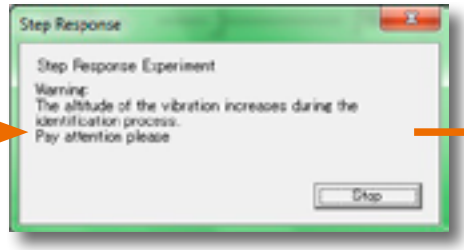
① To start the Step Test, click [Start] button.

* The motor will move 7.2 degree instantaneously during the test. Pay attention please.

② To stop the test process, click [Stop] button.

③ When the test process ends, click [OK].





Red line ＝ The simulation result from ③

Green line ＝ Real response for the same experimental condition

The step response is displayed. The experimental data is also displayed in [The instruction] box for every 2msec (1000pulse = 7.2 degree).

[Frequency Test]

Frequency response shows output gain(amplitude proportion) against input frequency command.

Gain (dB) shall be $20\log_{10}K$ and the output amplitude proportion against input shall be K time. When gain equals 0, the amplitude proportion equals 1. So that the same output amplitude as input amplitude shall be obtained.

Frequency characteristic has features as less intuition but minutia feature is well described.

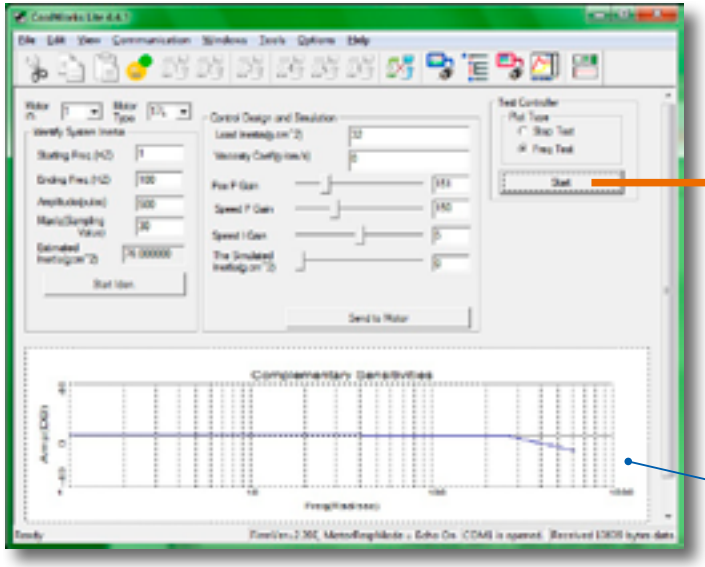
Frequency response test displays its response characteristic by increasing the amplitude 3.6 degree (500pulse / 50000ppr) sine wave from 1(Hz) up to 100(Hz) despite the motor's set resolution.

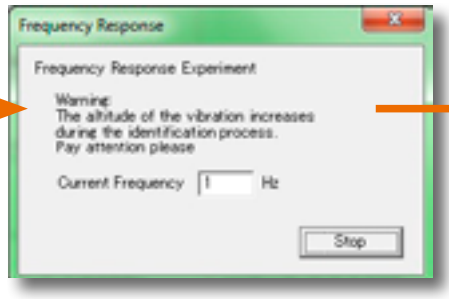
① To start the Frequency Test, click [Start] button.

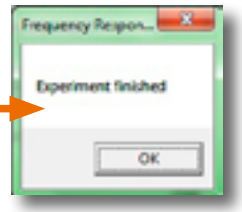
* The motor shaft will vibrate in the range of plus minus 3.6 degrees then the frequency of vibration will be increased gradually. Pay attention please.

② To stop the test process, click [Stop] button.

③ When the test process ends, click [OK].







X axis in frequency response graph is an angular frequency ω(rad/sec) and the formula in relation with the frequency f is ω(rad/sec) = 2π f

Ex) When 100(Hz), $2 \times \pi \times 100 \fallingdotseq 628$(rad/sec)

How to Use Response Adjustment Window (for CM2)

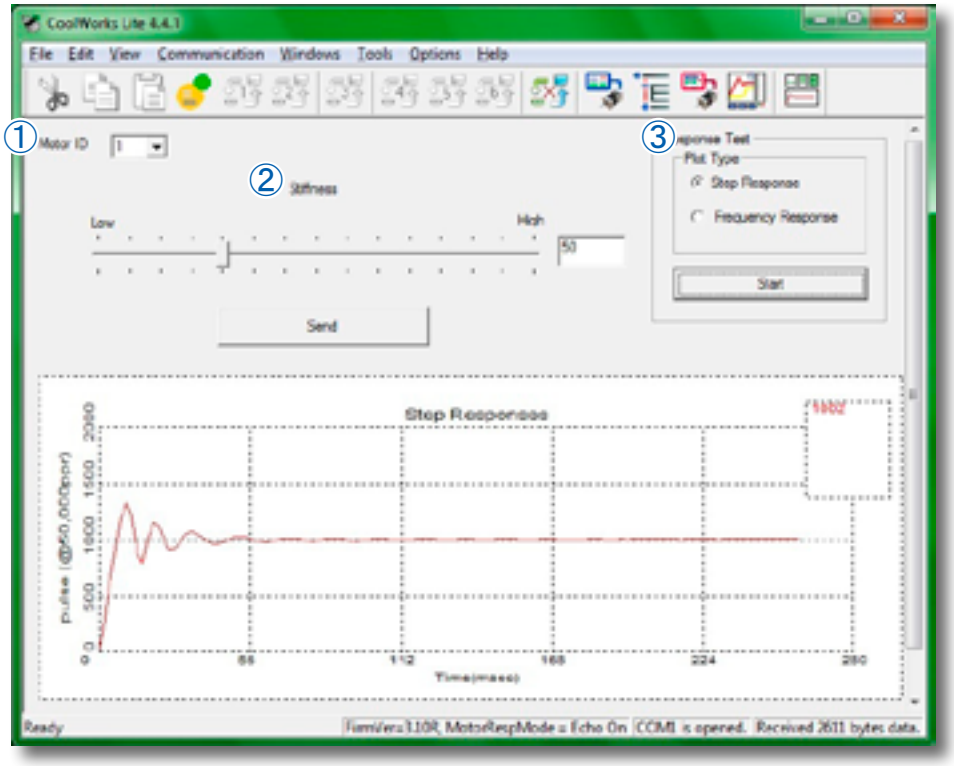
The servo stiffness for applied motor can be adjusted with using this screen.

① Motor Selection

Choose Motor ID .

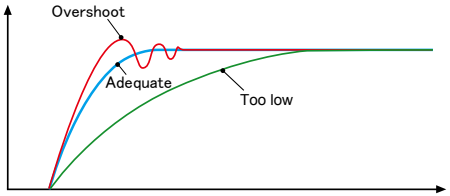
② Servo Stiffness Adjustment

The servo stiffness can be adjusted by moving the slider. Additionally, direct setting of numeric number into the right box is available for the adjustment.



③ Test Controller

Test results for Step and Frequency responses are available. (See Page 20 and 21 for details)



Setting is high ··· High servo stiffness and response are obtained. However, if too high, the servo system becomes unstable and the oscillating state or the overshoot tends to occur.

Setting is low ··· If too low, the response and tracking performance go down.

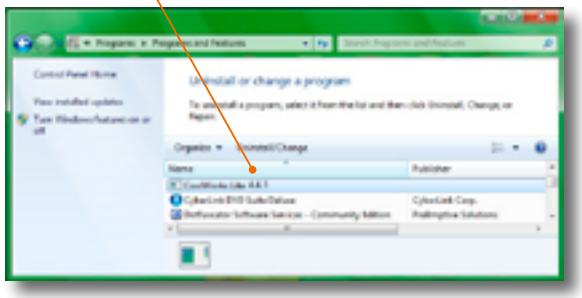
For adequate setting, adjust the servo stiffness to get no oscillation and less overshoot.

Chapter 9

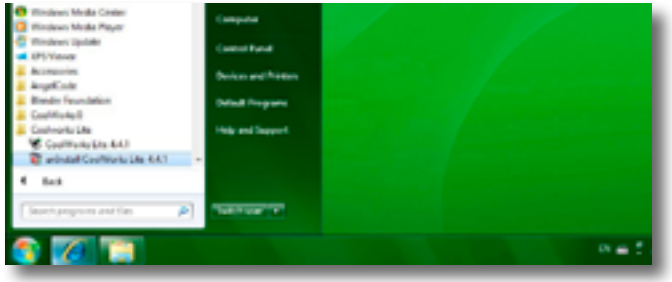
Uninstallation

1. There are two ways to uninstall CWL.

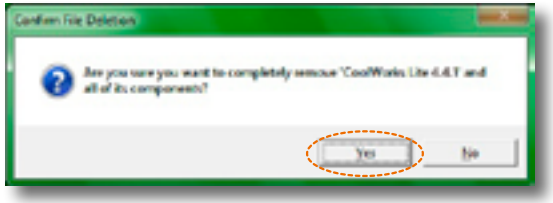
① Open the control panel for windows on the start menu / Programs / Uninstall a programs. Select CoolWorks Lite 4.4.1 and click [Uninstall / Change].



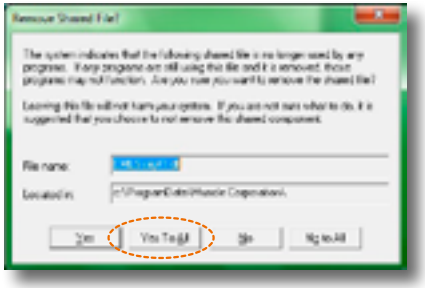
② Select the shortcut in start menu / All Programs / CoolWorks Lite / unInstall CoolWorks Lite 4.4.1.



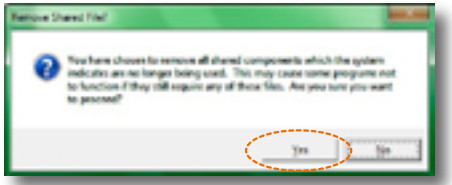
2. The following message will be displayed. Click [Yes] button.



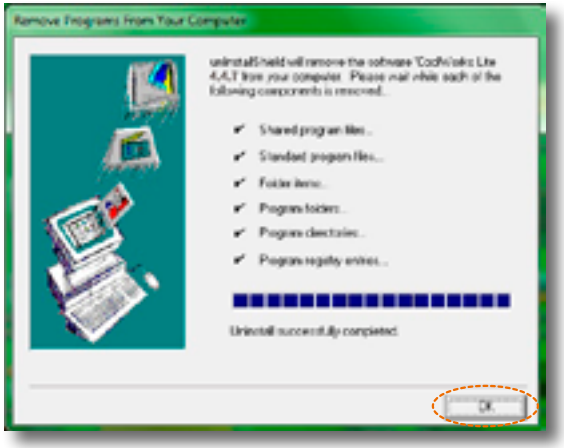
3. The following message will be displayed. Click [Yes To All] button.



4. The following message will be displayed. Click [Yes] button.



5. The uninstallation is successful if the following message window is displayed.

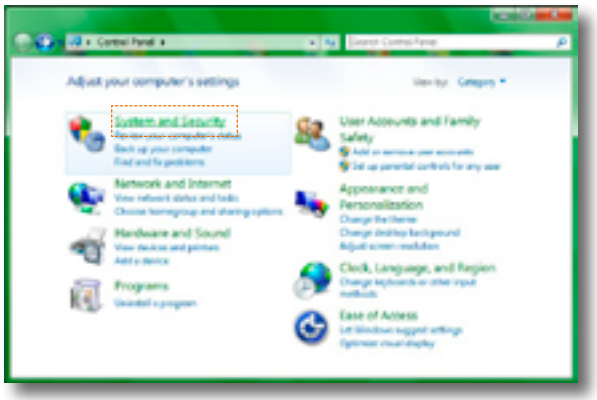


Chapter 10

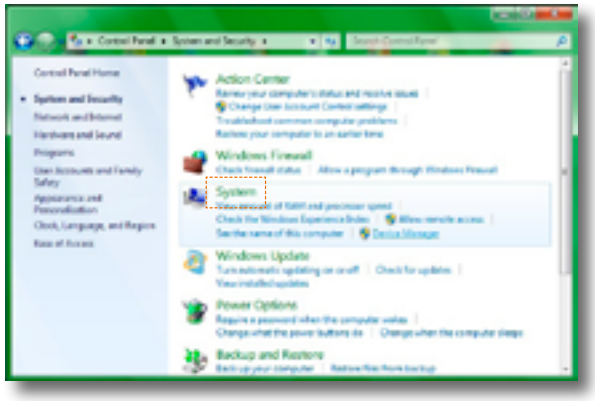
Appendix

How to find the COM port No. in Window XP

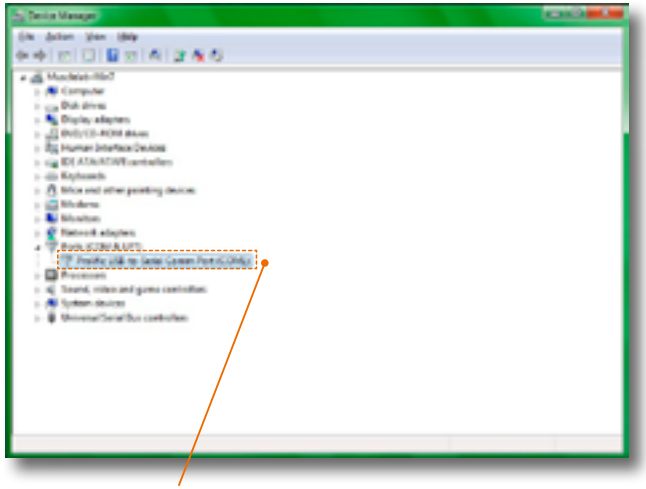
1. Open the Control panel, click [System and Security] and then [System].



2. Click [Device Manager] in [System].



3. The available COM ports are displayed in the tree selection [Ports (COM & LPT)] .



In this case, COM1 is available.

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